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**RADIOCOMMUNICATIONS AND SEARCH AND RESCUE**

**Recent developments in the COSPAS-SARSAT satellite system for search and rescue**

**Note by COSPAS-SARSAT**

**SUMMARY**

***Executive summary:*** This document highlights recent developments in the COSPAS-SARSAT Programme which include the addition of geostationary capabilities to complement the network of satellites in low-altitude polar orbit and preparations for the future phase-out of the 121.5 MHz satellite alerting capability. COSPAS-SARSAT will organize, in co-operation with IMO and ICAO, a Seminar in October 2000 in Canada to address these important issues.

***Action to be taken:*** Paragraph 27

***Related documents:*** None

## INTRODUCTION

1 The COSPAS-SARSAT satellite system for search and rescue provides distress alerts and location information to SAR services world-wide. Since the launch of the first polar-orbiting satellite in June 1982, COSPAS-SARSAT has provided assistance in rescuing over 10,000 persons in about 3,000 search and rescue operations world-wide. COSPAS-SARSAT assisted in the rescue of 1,334 persons during 1998, in 385 separate SAR incidents.

2 As of January 2000, the COSPAS-SARSAT System was composed of seven satellites in polar orbit, 35 ground receiving stations (LUTs) and 20 Mission Control Centres (MCCs) operated by 22 countries. Over 200,000 distress beacons operating at 406 MHz and about 600,000 of the older generation 121.5 MHz beacons were in service. COSPAS-SARSAT 406 MHz Emergency Position Indicating Radio Beacons (EPIRBs) have been accepted by IMO for the ship-to-shore alerting function of the GMDSS.

3 Following a two-year demonstration and evaluation, the COSPAS-SARSAT Council decided in October 1998 to adopt 406 MHz geostationary satellite components (GEOSAR) as a complement to the low-altitude, polar-orbiting system (the COSPAS-SARSAT LEOSAR system). This document highlights the major outcome of the 406 MHz GEOSAR Demonstration and Evaluation (D&E), and the implementation status of the 406 MHz GEOSAR system (see Figure 1).

4 Furthermore, in response to IMO's request and to the ICAO Council agreement that the 121.5 MHz COSPAS-SARSAT alerting service could be phased out from 2008, the COSPAS-SARSAT Council in October 1999 took several decisions of interest to IMO which are summarised below.

**DEVELOPMENT AND IMPLEMENTATION OF THE 406 MHz GEOSAR SYSTEM**

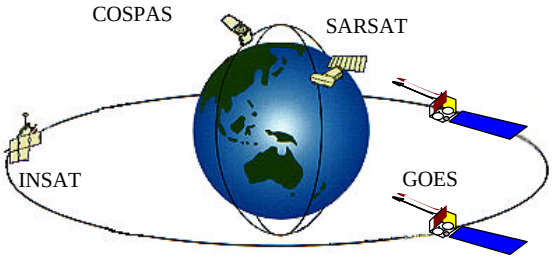


**Figure 1: Illustration of Combined 406 MHz LEOSAR and GEOSAR Systems**

**Report on the 406 MHz GEOSAR Demonstration and Evaluation (D&E)**

5 The 406 MHz GEOSAR system is composed of geostationary Earth-orbiting satellites and their associated ground processing facilities, that have the capability to detect transmissions from COSPAS-SARSAT type approved 406 MHz distress beacons. Geostationary satellites orbit at altitudes of 36,000 km at approximately 0° latitude and fixed longitudes, appropriate to the requirements of the space segment provider. Because of the high altitude and fixed orbit position of the geostationary satellites, the geostationary system has the potential to offer several complementary advantages to the low-altitude Earth-orbiting (LEOSAR) system. These advantages include near-instantaneous distress beacon detection and alerting, near-instantaneous beacon locating for beacons capable of calculating and transmitting their location, and continuous monitoring of the 406 MHz frequency band within the satellite footprint.

6 The goals of the 406 MHz GEOSAR D&E were to:

.1 characterise the technical and operational performance of the GEOSAR system;

.2 evaluate the operational effectiveness of the GEOSAR system and determine the benefits to search and rescue of combined LEOSAR/GEOSAR operations; and

.3 provide the basis for recommendations to the COSPAS-SARSAT Council.

7 A "COSPAS-SARSAT Demonstration and Evaluation Plan for 406 MHz GEOSAR Systems" was developed to provide the framework for the D&E. The Plan outlined ten technical and eight operational objectives for which tests were to be undertaken, with guidelines for data collection, reporting and analysis. The technical objectives were developed to address the technical compatibility of the various GEOSAR components and to establish the baseline characteristics of the GEOSAR system. The operational objectives were developed to evaluate the contribution to SAR operations of alert data provided by the 406 MHz GEOSAR system and to provide operational experience in the use of GEOSAR alerts. Data collection and evaluation

for the technical and operational objectives generally took place between July 1996 and February 1998.

8 Participation in the D&E was open to all COSPAS-SARSAT Participants. Geostationary satellites equipped with 406 MHz repeaters were available from the United States (the Geostationary Operational Environmental satellites, GOES-East and GOES-West, of the National Oceanic and Atmospheric Administration), and from India (the INSAT-2A geostationary satellite from the Indian Space Research Organization). D&E data were collected from experimental ground receiving stations in Canada, Chile, France, India, Spain and the United Kingdom. In addition, Australia, Canada, Chile, France, India, Spain, the United Kingdom and the United States contributed data in support of technical and/or operational objectives. The detailed D&E report was approved by the COSPAS-SARSAT Council in October 1998.

9 The successful completion of the ten technical objectives was hindered by radio frequency interference from a strong signal emanating from Peru. Because of the interfering signal which affected the two United States satellites providing coverage over the eastern part of the Pacific Ocean, the Americas and most of the Atlantic ocean, several of the technical objectives could not be accomplished or completed during the time frame of the D&E. The source of the 406 MHz interference was located using the COSPAS-SARSAT LEOSAR system and a Doppler location technique. It was later identified and switched off with the co-operation of the Peruvian Administration. The GEOSAR system continued to produce alerts, even in the presence of the interferer, however, the received data could not be used to characterise the system performance. The technical objectives of the D&E will be completed at the earliest opportunity. Despite this, the technical evaluation confirmed that:

.1 the GEOSAR system could detect transmitting beacons which met COSPAS-SARSAT technical specifications when they were in visibility of a geostationary satellite;

.2 the GEOSAR system provided near-instantaneous detection of 406 MHz beacon transmissions;

.3 beacon transmissions could be detected at elevation angles as low as $0^o$, and a $4^o$ elevation angle would provide a conservative estimate of the GEOSAR satellite coverage area where reliable reception of 406 MHz alerts was assured; and

.4 sufficient technical data had been collected to recommend the incorporation of the GEOSAR system as a complement to the COSPAS-SARSAT LEOSAR system.

10 Results from the eight operational objectives documented the performance and confirmed the effectiveness and benefits of the GEOSAR system, as summarised below.

.1 The GEOSAR system provided a useful time advantage over the LEOSAR system. The median time advantage of the GEOSAR alert was 21 minutes before the first corresponding LEOSAR alert, while the average was 46 minutes.

.2 The GEOSAR system was a good complement to the LEOSAR system. More than 85% of 406 MHz alerts within the 0° elevation angle GEOSAR satellite coverage areas were detected by the GEOSAR system and valid explanations existed for cases which were not detected, such as the blockage of the 406 MHz

beacon-to-satellite line of sight due to obstacles on the ground, or sub-standard beacon performance.

.3 There were many GEOSAR alerts, not detected by the LEOSAR system, that were single burst messages or transmissions of very short duration, which could be indicative of a large number of inadvertent activations or beacon tests. However, a short duration transmission could also be the only indication of a catastrophic event.

11 The completeness, accuracy, availability and 24-hour access capability of beacon registration databases were shown to be essential for the benefits of the GEOSAR system to be fully realised. The database information was used to:

.1 distinguish between real and false alerts and, consequently, was useful in preventing the launch of SAR resources on false alerts; and

.2 obtain rough location information, enabling SAR personnel to take advantage of the earlier notification provided by GEOSAR, even when encoded position information was not available in the beacon message.

**Summary of conclusions and recommendations from the 406 MHz GEOSAR D&E**

12 The D&E confirmed the complementary nature of the GEOSAR system and the 406 MHz LEOSAR system. Except for the polar regions over 75° latitude, the 406 MHz GEOSAR system provides a continuous coverage which allows quasi real-time alerting. However, it cannot support the Doppler location technique and, to achieve its full benefits, calls for the use of beacons which transmit position data acquired from internal or external navigation devices. The LEOSAR system provides a truly global coverage. It can compute the position of a distress using simple and fully autonomous beacons, but the non-continuous coverage imposes "waiting-times" which can significantly delay the reception of an alert at the RCC. However, the LEOSAR system has a very significant advantage on land, as it is not subject to complete blockage from obstacles on the ground. Eventually, the polar orbiting satellites will always fly near the zenith of the distress beacon.

13 The D&E clearly indicated that incorporation of the GEOSAR system components as a complement to the COSPAS-SARSAT LEOSAR system would generate significant benefits and would save additional lives and property. The D&E also highlighted the need to inform the 406 MHz beacon user community of the 406 MHz GEOSAR system performance. Greater care in the use of 406 MHz beacons will be required as inadvertent activations (even of short-term duration) would probably be detected by the GEOSAR system and could set off an unnecessary chain of events with a corresponding use of SAR resources.

14 As the D&E results had confirmed the expected benefits of the GEOSAR satellite system, the COSPAS-SARSAT Council decided to adopt the 406 MHz GEOSAR satellite system as an enhancement and complement to the COSPAS-SARSAT LEOSAR system and to initiate all actions necessary for implementing this enhancement as soon as possible, including the commissioning of the experimental receiving stations (GEOLUTs) used during the GEOSAR D&E. In order to ensure the optimal technical and operational performance of the enhanced COSPAS-SARSAT System, the COSPAS-SARSAT Council further recommended that:

.1 responsible administrations should establish and maintain complete, accurate, and up-to-date beacon registration databases, and make the corresponding information available to SAR agencies on a 24-hour a day basis;

.2 all manufacturers, administrations and others who develop educational programs and materials, should stress the importance of proper handling, shipping, storage and testing of 406 MHz beacons in view of avoiding false alerts; and

.3 responsible administrations should review 406 MHz beacon test policies and procedures, and revise them as necessary to avoid possible alerts from test transmissions being forwarded to RCCs as a result of the incorporation of GEOSAR components in the COSPAS-SARSAT 406 MHz system.

**Status of the 406 MHz GEOSAR system**

15 On the basis of the COSPAS-SARSAT Council decision to proceed with the integration of GEOSAR components as a complement to the COSPAS-SARSAT LEOSAR system, the United States notified ICAO in February 1999, as joint Depositary with IMO of the International COSPAS-SARSAT Programme Agreement, of the addition of the 406 MHz capability on the Geostationary Environmental Operational Satellites (GOES-East and GOES-West) to the United States contribution to the COSPAS-SARSAT Programme. The COSPAS-SARSAT Council is further considering how GEOSAR satellites from providers not currently a party to the International COSPAS-SARSAT Programme Agreement could be, in future, formally included as part of the COSPAS-SARSAT space segment.

16 In addition to GOES-East, GOES-West, and INSAT-2 satellites used during the GEOSAR D&E, geostationary satellites from Russia in the LUCH series, and the Meteosat Second Generation (MSG) satellites from EUMETSAT, planned for launch from 2000, will also be carrying 406 MHz repeaters, thus providing in the near future additional redundancy to the geostationary coverage at 406 MHz.

17 As of January 2000, the GEOSAR ground segment included 6 receiving stations (GEOLUTs). Although not yet formally commissioned to the COSPAS-SARSAT standard, these GEOLUTs are routinely providing distress alerts which are forwarded to the appropriate SAR services in accordance with the COSPAS-SARSAT Data Distribution Plan. Additional GEOLUTs are planned for operation in conjunction with the new GEOSAR satellites.

18 Finally, at the end of 1999, eight models of beacons (aviation ELTs, maritime EPIRBs and "personal" PLBs) with the capability to accept position data from internal or external navigation devices, essentially GPS receivers, had received a COSPAS-SARSAT type approval certificate. Since the GEOSAR system cannot use the Doppler processing technique to calculate the location of beacon alerts, these "location protocol beacons" will enhance the GEOSAR distress alerts. They can also enhance LEOSAR alerts, by providing location information even when insufficient numbers of beacon messages are received to enable the LUTs to calculate locations using the Doppler technique.

**FUTURE PHASE-OUT OF 121.5 MHz SATELLITE ALERTING SERVICES**

19 121.5 MHz beacons are available at a very low cost, but this out-dated technology, which cannot be improved easily, is the source of a very large number of false alerts (over 98% of all 121.5 MHz COSPAS-SARSAT distress alerts). Although these devices are not accepted as part of

the GMDSS, they are installed on board a large number of aircraft and are used at sea on board small craft and fishing vessels. The absence of an automatic capability for identifying 121.5 MHz alerts is also a serious limitation of the 121.5 MHz system which significantly increases the workload of Rescue Co-ordination Centres. This situation impacts on the efficiency of SAR operations and has led to a request by IMO for a termination of COSPAS-SARSAT processing of 121.5 MHz signals.

20 In 1999, the Council of the International Civil Aviation Organization (ICAO) adopted amendments to the annexes of the Convention on International Civil Aviation requiring all new aircraft from 2002, and all aircraft from 2005, under the jurisdiction of the ICAO Convention, to carry an Emergency Locator Transmitter (ELT) operating on 406 MHz, and on 121.5 MHz for homing purpose. The ICAO Council also agreed that COSPAS-SARSAT processing of 121.5 MHz ELTs could be discontinued from 2008.

21 In response to the request of IMO, and following the agreement of ICAO, the COSPAS-SARSAT Council decided at its CSC-23 session, in October 1999, that future satellites from COSPAS-13 (planned for launch from 2006) and SARSAT-14 (planned for launch from 2009) would not carry the 121.5 MHz search and rescue repeater (SARR) instrument. However, it should be noted that all COSPAS satellites to be launched prior to COSPAS-13, and all SARSAT satellites to be launched prior to SARSAT-14 will be equipped with the 121.5 MHz SARR.

22 COSPAS-SARSAT has decided to complete in 2000 the development of a 121.5 MHz phase-out plan to assist Participants in the System, as well as Administrations and users, in their preparation for the discontinuation of this service. In particular, as part of the preparations for the phase-out of 121.5 MHz satellite alerting, Administrations should develop information campaigns to ensure that all appropriate users, regulatory bodies and manufacturing concerns are kept informed of the progress of the phase-out.

23 About 600,000 beacons operating at 121.5 MHz will have to be replaced either by 406 MHz equipment or other means of alerting, prior to the cut-off date of the 121.5 MHz satellite alerting service. Therefore, a major aspect of the phase-out preparation is to ensure the availability of 406 MHz ELTs/EPIRBs for use as replacement of the 121.5 MHz beacons, and the management of the 406 MHz beacon population growth prior to the cut-off date. Preliminary studies have indicated that the COSPAS-SARSAT GEOSAR and LEOSAR systems have sufficient capacity to accommodate a significant growth of the 406 MHz beacon population, provided the carrier frequency is adequately spread over the assigned bandwidth (i.e. 406.0 to 406.1 MHz).

24 To achieve this objective, COSPAS-SARSAT is developing a 406 MHz Frequency Management Plan which will define the appropriate channelisation of the 406 MHz band, and the required amendments to the 406 MHz ELT/EPIRB specification and type approval standard, allowing for the production of beacons with the appropriate carrier frequency. IMO and ICAO will be informed as soon as possible of the proposed amendments to the 406 MHz beacon specification to ensure appropriate co-ordination and the timely updating of the corresponding international specifications (i.e. Recommendation ITU-R M.633 and Annex 10 to the ICAO Convention).

**COSPAS-SARSAT 2000 SEMINAR**

25 The future phase-out of 121.5 MHz satellite alerting services and the introduction of a 406 MHz GEOSAR capability are major developments which call for close co-operation between all Participants in the COSPAS-SARSAT System, Administrations responsible for regulatory aspects of maritime and aviation safety, SAR services, manufacturers and user organizations.

Therefore, the COSPAS-SARSAT Council decided to hold a COSPAS-SARSAT Seminar in Laval near Montreal, Canada, from 12 to 14 October 2000, in co-operation with IMO and ICAO. The COSPAS-SARSAT 2000 Seminar will be held in conjunction with the annual SAR*SCENE* Workshop and Trade Show co-hosted by Canada's National Search and Rescue Secretariat (NSS) and the volunteer group Sauvetage Canada Rescue (SCR).

26 The COSPAS-SARSAT 2000 Seminar is designed to provide a unique opportunity to:

.1 update Seminar participants on the status of the COSPAS-SARSAT System;

.2 provide information on new developments and pending changes in the System; and

.3 promote a dialogue with manufacturers and Administrations on the operation of the System, and discuss specific issues regarding:

.3.1 the necessary preparation for future phase-out of 121.5 MHz satellite alerting services;

.3.2 the management of the continuing growth of the 406 MHz beacon population;

.3.3 406 MHz beacon registration, coding and control;

.3.4 the reduction of false alerts; and

.3.5 the distribution of LEOSAR and GEOSAR alert data to RCCs/SPOCs.

**ACTION REQUESTED OF THE COMMITTEE**

27 The Committee is invited to note the information provided on recent and pending developments in the COSPAS-SARSAT satellite system for search and rescue, in particular the on-going integration of geostationary satellite capabilities for enhancing the satellite alerting service provided to 406 MHz ELTs, EPIRBs and PLBs, and the future phase-out of the 121.5 MHz satellite alerting service, as decided in response to IMO's request.

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